

The chapters on feces and vomiting are of much less interest, as is also the case with those on the bones, cartilage, muscle, &c., but that on concretions is highly valuable, as it points out the composition of vesical and renal calculi, the best methods of ascertaining their character, even by persons little skilled in chemical manipulation. The work concludes with a short view of the fluid products of disease, and an appendix containing further analyses of many substances previously mentioned.

Such, in a few words, are the subjects treated on by the author, and it will be perceived that he has occupied a wide field of observation, and it is much to be regretted that his untimely death prevented us from profiting by the extension of his researches so ably commenced. His observations, as now presented, are calculated to lead to very important results, and throw much light on many of the most obscure departments of physiology, and we feel satisfied that they will tend to encourage a taste for a science, from whose cultivation and development the medical art will derive the utmost benefit.

R. E. G.

ART. XIX.—*Fifth Annual Report of the Registrar-General, of Births, Deaths, and Marriages, in England.*

In a bibliographical notice of the above-named work, formerly presented in this Journal,\* we promised to enter into some examination of the letter of Mr. Farr, the able statistician, which accompanies, and greatly enhances the interest of the Registrar-General's valuable publication.

In the appendix to the first report, noticed in this Journal for October, 1842, (vol. iv. p. 426,) the proportion of deaths in towns and the open country, was a subject of investigation, and the much higher rate of mortality in towns referred to. The inquiry at that time necessarily left some uncertainty in the results, since it was founded upon the returns of half a year, and the population could only be estimated on an assumed rate of increase. The census taken subsequently furnishes a mass of facts which afford more ample means of determining the influence of the density of population on the causes of death. For the sake of comparison with the appendix of the first report, Mr. Farr takes the same districts and pursues the same order.

He informs us that the country population in 1841, of the districts in the counties of Essex, Norfolk, (except Norwich,) Suffolk, Gloucestershire, (except Bristol and Clifton,) Herefordshire, and Westmoreland, an area of about 9,352 square miles, was 1,700,484. The deaths registered in the four years, (1838-41,) were 132,116.

The town population of Birmingham, Aston, Bristol, Clifton, Manchester, Salford, Liverpool, West Derby, Cambridge, Carlisle, Derby, Dudley, Exeter, Leeds, Leicester, Maidstone, Newcastle-on-Tyne, Sunderland, Northampton, Sheffield, Stoke-on-Trent, Wolstanton, and Wolverhampton, covering 666 square miles, was 1,883,693; and the deaths in four years 205,966.

The population of the town being greater than that of the country districts, as a correction of this excess, Mr. Farr strikes off 20,000 from the deaths in the former districts, and makes the mortality in the same time and out of the same population 132,116 in the country districts, and 185,966 in the towns, showing an excess in the latter of no less than 53,850 deaths.

In another statement he includes the mortality of London, inhabited, in 1841, by the enormous population of 1,875,493. The deaths in the metropolis are compared with those in the South-Western Division, comprising, in Wiltshire, Dorsetshire, Devonshire, Cornwall, Somersetshire, a population of 1,740,017. The deaths were 189,927 in the metropolis, and 130,298 in the South-Western Division; and after the same kind of correction as before, the result is of the same character, the deaths being in the same time, (4 years,) out of the same number of inhabitants, 130,298, in the rural, and 176,210 in the metropolitan districts.

The excess in the London mortality amounts to 45,912. Taking the same po-

\* See Amer. Journ. of Med. Sciences, for Oct., 1845, p. 390.

pulation, a greater number died in 3 years in the metropolitan districts than died in 4 years in the south-western districts. If the mortality were reduced to the same rate, there would be 13,700 less funerals in the metropolis every year.

By combining the two series of observations just noticed the following aggregate numbers are obtained:—

Deaths in the same time (4 years) out of the same population 262,414, in the country districts, and 362,176 in the town districts. Difference, 99,762.

During the 10 years which embrace the 4 years included in this calculation, the annual increase of population was 2 per cent., in the town, and only 8 in the country districts. One in 52 died in the country, 1 in 37 in the town districts. The mortality in the dense districts was to that in the less dense districts as 140 to 100.

Mr. Farr presents tables constructed to show the causes of death in the country and town districts. From these it appears that the deaths by diseases of the zymotic class were 86,835 in towns, 45,114 in the counties; and the annual mortality was 6013 and 3422 in a *million* living. "By small-pox the mortality was twice as great in the town as in the country districts (1045 and 507); 8348 persons died by this disease in the '25 towns,' (so they may be called for shortness,) and 6739 in the metropolis, 3844 in the south-western division, 2834 in other counties. The mortality (in a *million*) by *measles* was 914 in the town districts, 364 in the country; by *scarlatina* (including putrid sore throat) 988 and 478; by *hooping-cough* 829 and 415. Thus 8465 (children chiefly) died of *measles* in the '25 towns,' 2774 in the south-western division, 4729 in the metropolis, and 2021 in the 'eastern, &c., counties;' 7627 died of *scarlatina* in the '25 towns,' and 2499 in the south-western division, 6640 in the metropolis, and 3801 in the eastern and other counties. *Hooping-cough* was fatal to 11,975 in the metropolis and the '25 towns,' to 5468 in the south-western division and the other counties. *Croup* was much more fatal in the '25 towns' than in the metropolis, while it was the reverse with 'thrush,' and neither of these maladies was much more fatal in the town than in the country districts. The mortality of *diarrhœa*, *dysentery*, and *cholera* together, was 385 in the towns, 196 in the country. *Typhus* (comprising the cases returned as *fever*) was fatal to 18,111 in the town, 13,159 in the country districts: the mortality (to a *million* living is understood throughout) was 1254 and 997. The mortality from *erysipelas* was 133 and 53; from *syphilis* (as returned) 18 and 10 in a *million*. *Twenty-eight* died of *hydrophobia* in the towns, 10 in the country districts.

"The diseases of 'uncertain or variable seat' were nearly equally fatal in the two classes of districts. More deaths were referred to *scrofula* and *carcinoma* in the country than in the town districts; 13,194 persons died of dropsies in the town, 12,040 in the country districts.

"The mortality by *cephalitis* and *hydrocephalus* together was 1143 in the town, 445 (to a *million*) in the country districts. *Hydrocephalus* destroyed 4409 children in the country, 12,656 in the town districts. The mortality by convulsions was 852 in the country, 2090 (to a *million*) in towns, where *tetanus* and *chorea* were also most fatal. The mortality by *apoplexy* and *paralysis*, as well as the 'sudden deaths,' in which inquests were held, was not much greater in towns than in the country. By *phthisis* the mortality was 4463 (in a *million*) in the town, 3660 in the country districts: or 64,449 persons died by this disease in the town, 48,252 in the country districts. The mortality by *phthisis* was raised only 22 per cent. in the town districts; but in this destructive disease the increase produced 16,197 deaths, while the *total* deaths from *typhus* in towns was but 18,111, and the excess over the deaths from that disease in the country 4952. Sufficient attention has perhaps not been paid to the great excess in the mortality of consumption, caused by the insalubrity of towns. The deaths by *bronchitis*, *pneumonia*, *asthma*, and other diseases of the chest, were raised from 21,966 in the country to 50,609 in the town districts; the mortality was 1667 and 3504 in a *million*.

"The annual mortality by diseases of the *digestive organs* was 1972 (to a *million*) in the town, 1042 in the country districts; but of this mortality 616 and 120 were referred to *teething*, a disproportion which, vague as the term is, serves to indicate the greater degree of irritation and danger of dentition in towns. Enteritis and

peritonitis were nearly twice as fatal in the town as in the country districts. *Tuberculosis mesenterica* was, like consumption, increased only about one-fifth in the town districts. By liver disease and hepatitis the mortality was 171 in the country, 233 in the town districts; by jaundice 55 and 57. The mortality by diseases of the urinary organs was 101 in the country, 117 in the town districts. The mortality by diabetes was the same (13); by stone and gravel 12 in the country, 16 in the towns. The excess was perhaps caused by the resort of patients to the hospitals in towns.

"Of childbirth, 3195 women died in the town, 1806 in the country districts; the excess in towns was more than 1000 lives; the mortality was 221 and 137

"The mortality by rheumatism was greater in the towns than in the country (72 and 48); so was the mortality by diseases of the joints.

"The mortality ascribed to intemperance was 19 in the town, 7 in the country districts; to starvation, 15 in the town, 8 in the country districts.

"I have pointed out only some of the more important results in the table, which should be carefully studied in all its details.

"The essential character by which we have been guided, in classifying districts under the head of 'town' or 'country,' is the density of the population, which can be expressed numerically by the 'population to a given area,' or the 'area to each person.' Whether the population possesses any privileges, is incorporated, or is under any peculiar jurisdiction; whether the place is technically a 'city,' or a 'town,' or neither, has not been considered; if the district have a considerable population, living in close proximity, it is considered a 'town' district. The Registration Districts are generally single parishes, or parishes united for the relief of the poor, and were formed by the Poor Law Commissioners with this object exclusively in view; hence the 25 town districts comprise entire parishes, which have all the character of country districts, and the municipal boundaries themselves frequently take in open suburbs and spaces. The width of the streets, and the relative area covered with dwellings, also differ in the same city.

"Upon the other hand, the 'country' districts in the table comprise all the towns in Wiltshire, Devonshire, Dorsetshire, Cornwall, Somersetshire, Norfolk (except Norwich), Gloucestershire (except Bristol and Clifton), Herefordshire, and Westmoreland. The terms 'town' and 'country' districts must consequently be understood in this inquiry to designate prevailing and not exclusive characters. The comparison is instituted between denser and less dense, not between the densest and most scattered populations in the kingdom. Assuming that the mortality is increased as the population grows denser, the mortality of the class of 'town districts' is less, that of 'country districts' greater, than it would be if the population were exclusively of the kind by which the class is characterized. The effect of the agents is understated by which the disease and mortality of towns are caused. It is as if the specific gravities of two masses of metal were compared; the one containing eight, the other two parts in ten of gold; the ratio of the specific gravities of the two masses would be less than the ratio of the specific gravities of the pure metals; but a comparison would prove incontestably that gold was by far the heaviest.

"Without any difficult analysis this broad irrecusable result is then obtained from an immense number of facts, that certain diseases are much more fatal, and that the mortality is much greater in towns than in the open country."

Mr. Farr proceeds next to inquire into the agencies leading to the production of diseases which prove so much more destructive in towns than in the country. He traces the disease of towns to groups of causes, and of these gives a partial analysis.

"Experience," he observes, "has shown that there are certain things which may be called necessities of life; they are the produce of labour, and possess a variable value; a portion therefore of every population, savage or civilized, cannot procure them, and is subject to privation in different degrees. These necessities are—(1.) Water (beer, wine, tea, coffee); (2.) Food (meat, bread, fruits, vegetables); (3.) Physic; (4.) Clothing; (5.) Firing (light); (6.) Lodging; (7.) Cleansing, (washing, sewerage.) The relative value of these articles is represented by their price, which varies at different times and places, but the price does not express the relative facility of procuring them, that is, of procuring,

in the wide sense of the word, subsistence. The facility is expressed by the ratio of the earnings of a family to the cost of its subsistence; for if the seven necessities of life cost 100*l.* in one place and 120*l.* in another, and the earnings are also 100*l.* and 120*l.* respectively, each family would have a competency. But competency, comforts, and the *aisance* of the French, significant as they are, cannot be expressed numerically; they may be understood differently; in a sanitary inquiry, we may, therefore, substitute for them the value of this ratio, which can be determined and expressed in terms to which all would attach the same signification. Let it be assumed, for a moment, that a sufficient supply of the necessities of life can be procured by a family for 100*l.* a-year, what would be the effect of reducing the earnings of the family to 50*l.* a-year? We know, by observation, that it does not reduce the duration of life in that ratio; and the reason is, that by the substitution of a coarser and cheaper food hunger can be appeased, and the body supplied with sufficient nutritive matter, or matter which may serve as a substitute for those more grateful combinations, which the appetites and experience seem to point out as the best food for mankind. The animal food in the case supposed, would be replaced by bread or potatoes; the beer, tea, and coffee, would be weaker; in illness medical advice would be less frequently obtained; the clothing would be coarser and scantier; the fire smaller; the lodging less spacious; cleanliness would be less attended to. I take here the average results, which would vary in different circumstances with the desires of the people and the products of the place. A reduction from abundance to a rude subsistence would probably be attended by a reduction in the mean duration of life, but to a comparatively small extent. A low standard might, however, be fixed upon, any fall below which would be accompanied by a certain reduction of the mean life of the people."

Among other influences affecting life and health, Mr. Farr refers to those of soil and atmosphere, climate and seasons, winds, temperature, hygrometricity and electricity.

In relation to another class of agents, namely, atmospheric impurities, organic matter undergoing decomposition, and the contagious principles of zymotic diseases, our author makes the following observations:

"The atmosphere, besides oxygen and nitrogen, contains carbonic acid and aqueous vapour. The mean proportion of carbonic acid is 49 volumes in 100,000 volumes of air, according to the younger Saussure; who also states that it varies from 37 to 62 volumes. Mr. Coathoupe has estimated the quantity of air which passes through the lungs of a man of ordinary size in 24 hours at 267 cubic feet, of which nearly 8 per cent. by volume, or 21 feet, are exchanged for carbonic acid;\* the bulk would be equivalent to a cube of 6.4 feet. If, for a mere illustration, we assume that on an average 16 cubic feet of the gas are thrown off from the skin and lungs of each person, 30 million cubic feet will be exhaled daily by the population of the metropolis, distributed over an area of about 1951 million square feet. Add the amount of the same gas formed by animals of every kind, —fires, lamps,—and multiply the sum by 100, inasmuch as respiration for several hours in air which contains 1 or 2 per cent. of carbonic acid has been found to produce alarming effects (Broughton), and it will be seen that the amount of air vitiated in the metropolis, by this element alone, is by no means inconsiderable.

"Is the excessive mortality, then, in towns, to be ascribed to the accumulation of carbonic acid, or of any other similar gas, which is so rare, as to be innocuous in open districts? It was natural, when it had been discovered that carbonic acid mixed in air destroyed animals, and after the accidents in mines and close chambers had been traced to this agent, to ascribe the excessive mortality of towns to the same cause. Further investigation must show, I think, that it has but a small share in raising the mortality of towns, the provision for its dispersion is so complete."

Connected with this topic Mr. Farr has communicated some facts and observations relating to the diffusion of gases in the atmosphere, of such exceeding interest that we cannot refrain from laying some of them before our readers.

"Dalton discovered that carbonic acid entered the space occupied by hydrogen

\* Graham's Chemistry, p. 1016.

in the same proportion as if no hydrogen had been present. He inferred that gases do not, like liquids, exclude each other, and this is now admitted. So that if an air-tight chamber full of carbonic acid communicate with the external air, the same quantity of air will find its way into the chamber as if no carbonic acid gas were present; and if water were introduced, the same amount of aqueous vapour would occupy the space as if neither gas were present. The elasticity and density of the atmosphere of the chamber would be the sum of the densities and elasticities of all the gases and vapours present. It has been assumed here, to simplify the statement, that while the atmospheric air entered the carbonic acid gas remained; but it would in fact go out, for the same reason that the air entered in order to set the gases without and within in equilibrium."

A great deal of light has been thrown upon the subject of the rates at which gases are diffused through small apertures and porous substances, by Professor Graham, in his *Elements of Chemistry*. To form an idea of the dispersion of the carbonic acid gas generated in towns, according to the pneumatic law, "assume," says Mr. Farr, "that 1000 cubic feet are formed per second; it will be equal to a cube of 10 feet. Now if this volume of carbonic acid were in the centre of a vacuum, it would disperse in every direction at a velocity of 1049 feet a second. It is nearly the velocity of sound. A particle would fly a mile in 5 seconds, 12 miles in a minute. The velocity of a 'high wind' is 50 feet a second, 'a hurricane that tears up trees' 147 feet a second—one-seventh of the velocity with which carbonic acid rushes into a vacuum. If the gaseous film evolved every second over the area of the metropolis were pure air, it would only move slowly away, by the impulse with which it was thrown off, and because it was lighter than the atmosphere; but as it is carbonic acid, the surrounding atmosphere is a vacuum, into which its rush is opposed only by the small quantity of carbonic acid gas existing, and the sluggishness of the aerial particles. The rapid removal of this gas from cities is effected by a force much greater and altogether independent of the winds. It is carried rapidly through the air, until it is fixed again by vegetation and exchanged for oxygen, which flows into the atmosphere of cities, according to the same law, to replace the oxygen consumed.

"These results are confirmed by chemical analysis of the air. The differences in the quantity of carbonic acid in winter and summer, night and day, are considered by Dumas due to more of the gas being absorbed, retained, and brought down by rain in cold than in warm weather. They are meteorological changes extending over all the atmosphere. Chemists have hitherto failed to detect any excess of carbonic acid gas in cities. A commission is now sitting in Paris, engaged in the analysis of the atmosphere by Dumas' method, which is held to yield the most accurate results. I am not aware that the air of any place in England has been analyzed by the new method; but the observations in other countries show no diminution of oxygen in the city air. Thus the oxygen was to the nitrogen in the air of Paris as 230.0 to 770.0 (by weight); and on Faulhorn, in Switzerland, 8767 feet above the level of the sea, as 229.7 oxygen to 770.3 nitrogen.

"Carburetted hydrogen and sulphuretted hydrogen arising from graves are less dense, and are dispersed more rapidly than carbonic acid: scarcely a trace of them can be detected.

"Carbonic acid and other noxious gases can, as is well known, be confined for a time in well closed apartments, and oxygen can be excluded; but the dispersive force is so great that chemists have seldom succeeded in detecting any difference in the proportions of the gases, even in the air of crowded hospitals. If any difference exist it must be small, and might have a slight effect on health; but, as the experience of our collieries proves, would not raise the mortality to anything beyond a fraction of 40 per cent.; besides, the country is exposed as well as the town population to the influence of deleterious gases in the close chambers of small cottages.

"It is, then, to matters suspended in the atmosphere of cities that the excessive mortality must be referred. Smoke is heated gas, carrying with it unburnt particles in suspension; the carbonic acid is scattered immediately by its diffusive velocity, and the particles of solid matter, carried up by the heated air into the sky, disperse, become invisible, and fall around insensibly, in a clear atmosphere, or



at a distance when there is any wind. If the air contain watery vesicles also in suspension, the column of smoke ascends but a little, the carbonic acid is absorbed, the carbon imbibes water and air, it mixes with the watery cloud, and all the phenomena of a London fog are produced. These fogs are caused, apparently when the temperature of the Thames is higher than the temperature of the air, which is calm (or if there be any wind it is nearly saturated), the fogs generally disappearing as the temperature of the air is raised by the sun.

"That the smoke is irritating to the air-passages, injurious to the health, and one of the causes of death, to which the inhabitants of towns are more exposed than the inhabitants of the country, is exceedingly probable; but if the effect were very considerable it would be most evident in the dense fogs, when the atmosphere is loaded with smoke, and breathed for several consecutive hours by the population—men, women, and children. Now we have never observed any connection between the increase of the mortality and the London fogs. The diseases, again, caused by smoke must be of a mechanical nature, and affect the lungs and air-passages; it may increase the pulmonary diseases, but will assuredly not produce scarlatina, measles, typhus, and other diseases which prevail in towns.

"There is another class of agents. In a school-room, say there are 100 children: a child is introduced for a few hours, in a state of scarlatina. The children have not had the disease before: 10 of them are affected. If 10 children with scarlatina were introduced, and the room were ill ventilated, 30 or 40 of the children might be affected. If, instead of scarlatina, the sick children had small-pox, measles, or whooping-cough, these diseases would be communicated. If dysentery, cholera, typhus, and plague patients are frequently introduced into barracks or workhouses, a certain proportion of the inmates are affected. The numbers who are attacked by an infectious disease depend upon—1st. The susceptibility of the person exposed (if the children in the school-room had previously had small-pox, or been vaccinated, a very small proportion of them would be infected by breathing the small-pox atmosphere); 2dly, on the strength of the zymotic matter, which varies in the stages and forms of the several diseases; and 3dly, on the density and ventilation of the room. If 100 healthy were placed in a room in immediate contact with 10 sick persons, if the room were small, the doors and windows closed, the greatest number possible would be infected; and if they went through the disease in the same circumstances, the mortality would also be the greatest possible. So if public buildings, in which crowds of people assemble, were well supplied with pure air, it would be quite safe to resort to them; but as opera houses, theatres, concert rooms, lecture rooms, Exeter-hall, chapels, churches, and large workshops, are not yet provided with the proper mechanical means of ventilation, and the air is not withdrawn, the very walls reek, when filled with the breathed atmosphere; and if any epidemic, such as influenza, be rife, several persons affected with the complaint are present, and great numbers are infected; the headache and oppression which come on are the first and often not the last symptoms. This is literally 'taking poison;' but it is generally called 'taking cold,' through the common prejudice of ascribing all our maladies to sensible causes. It is a vulgar error to suppose that rooms are healthy when they are not hot; but the heat which is generated may increase the effect of the zymotic matter.

"Certain substances, then, taken from the bodies of the sick, produce, when introduced into other bodies, a series of specific phenomena, developed according to a determined type: *Varioline* (small-pox matter), for instance, produces small-pox. These substances have the same relation to diseases as ferments have to well-known chemical processes. Several of them will float in the air, and form a morbid atmosphere, the density of which will be in proportion to the proximity of the bodies by which it is given off, and to the greater or less facility for escape. The 267 feet of air passing through the lungs daily, if charged with these particles, will bring them into contact with the blood.

"What are the physical properties and chemical nature of these morbid particles? Chemistry has left us much in the dark; but, until English chemists enter seriously upon the investigation of this subject (which is of inconceivable importance), we may accept the well-supported hypothesis of Professor Graham:—

“Of the odoriferous principles of plants, the miasmata of marshes, and other matters of contagion, the presence, although sufficiently obvious to the sense of smell, or by their effects upon the human constitution, cannot be detected by chemical tests. But it may be remarked, in regard to them, that few or none of the compound volatile bodies we perceive entering the atmosphere could long escape destruction from oxidation. The atmosphere contains, indeed, within itself the means of its own purification, and slowly but certainly converts all organic substances exposed to it in simpler forms of matter, such as water, carbonic acid, nitric acid, and ammonia. Although the occasional presence of matters of contagion in the atmosphere is not to be disputed, still it is an assumption without evidence that these substances are volatile or truly vaporous. Other matters of infection, with which we can compare them, such as the matter of cow-pox, may be dried in the air, and are not in the least degree volatile. Indeed, volatility of a body implies a certain simplicity of constitution and limit to the number of atoms in its integrant particle, which true organic bodies appear not to possess. It is more probable that matters of contagion are highly-organized particles of fixed matter, which may find its way into the atmosphere, notwithstanding, like the pollen of flowers, and remain for a time suspended in it; a condition which is consistent with the admitted difficulty of reaching and destroying those bodies by gaseous chlorine, and with the washing of walls and floors as an ordinary disinfecting practice.”

“It is quite certain that animal matter is exhaled from the pulmonary and cutaneous surface. The particles are small and rare; but, according to Graham, they are inelastic; they are without that diffusive force inherent in gases and vapours, and will therefore only spread through the air like vesicular water, or fine dust over smooth water. When the breath is expired in winter, it passes from the lung with a certain force; but it instantly separates into two portions; 1st, the carbonic acid, which would fall to the ground if it were not dispersed in all directions by the diffusive force; and 2dly, the aqueous vapour which ascends with the heated air and particles of animal matter; the air to mix in air, the water to be condensed, fall, or be dissolved, and the animal matter to fall or be decomposed in the air. In a crowded room, theatre, or church, the carbonic acid is dispersed through every aperture at a retarding velocity. The gas exhaled from the body does not ascend to the roof, as is sometimes supposed, when the temperature of the room is low, for the specific gravity of carbonic acid is 1.524; and, as the density is inversely as the volume, and gases expand 1.493d part (Rudberg) for every degree of Fahrenheit, it only becomes lighter than air when 258 degrees hotter. The carbonic acid emitted from the lungs at a temperature of 100° is more than a third heavier than air at 40°: its density is 1.359, air being 1.000. The carbonic acid emitted by the candles or gas of a room is more than as light again as air; but it soon cools and grows heavier, and, if it were not for the diffusive force, would fall to the ground. Gases cannot remain permanently at the upper or lower parts of any apartment or edifice in other proportions than they exist in the atmosphere; it would be easier for a torrent to stand still on a mountain declivity. They disperse, and can only accumulate around their source when generated rapidly. But particles in suspension—inelastic, smaller, lighter than motes in the sunbeam—stagnate in air, and can only fall to the ground, or be carried away with the fluid in which they float. Smoke and organic matters are removed from a room in the same way—by replacing all its gaseous contents; and particles of both are left adherent to the exposed surfaces, but in quantities smaller in proportion to the velocity of displacement.

“Every population throws off insensibly an atmosphere of organic matter, excessively rare in country and town, but less rare in dense than in open districts; and this atmosphere hangs over cities like a light cloud, slowly spreading—driven about—falling—dispersed by the winds—washed down by showers. It is not *vitalis halitus*, except by origin, but matter which *has lived*, is dead, has left the body, and is undergoing by oxidation decomposition into simpler than organic elements. The exhalations from sewers, churchyards, vaults, slaughter-houses, cesspools, commingle in this atmosphere, as polluted waters enter the Thames; and notwithstanding the wonderful provisions of nature for the speedy oxidation of organic matter in water and air, accumulate, and the density of the poison (for

in the transition of decay it is a poison) is sufficient to impress its destructive action on the living—to receive and impart the processes of zymotic principles—to connect by a subtle, sickly, deadly medium, the people agglomerated in narrow streets and courts, down which the wind does not blow, and upon which the sun seldom shines.

"A small quantity of organic matter can only escape with the carbon and aqueous vapour, (37½ ounces daily, according to Dalton,) from the skin and lungs. The presence of a putrid atmosphere is too evident in parts of all towns; and Liebig, by operating on large masses of the atmosphere, has obtained ammonia, which is a product of the putrefaction of animal matter. The existence in the atmosphere of organic matter is, therefore, incontestable; and as it must be most dense in the densest districts, where it is produced in greatest quantities, and the facilities for decomposing it in the sunshine and sweeping it away by currents of wind are the least, its effects—disease and death—will be most evident in towns, and in the most crowded districts of towns.

"It is to this cause, it appears to me, that the mortality of towns is to be ascribed; the people live in an atmosphere charged with decomposing matter, of vegetable and animal origin; in the open country it is diluted, scattered by the winds, oxidized in the sun; the vegetable world—the great organizer—incorporates its elements, so that, though it were formed, proportionally to the population, in greater quantities than in towns, it would have less effect comparatively. The means of removing impurities in towns exist partially, and have produced admirable effects; but the most casual observation must convince any one that our streets were built by persons entirely ignorant of the nature of the atmosphere, and of the mortality which has been proved to exist, and is referable to causes which, though invisible, are sufficiently evident. Every one feels the difference of the polluted and the pure atmospheres described by Milton:—

"As one who long in populous city pent,  
Where houses thick and sewers annoy the air,  
Forth issuing on a summer's morn, to breathe  
Among the pleasant villages and farms  
Adjoin'd, from each thing met conceives delight."

"I shall proceed to show, not only that the mortality is greater in the town than in country districts, but that the mortality of town districts has a certain relation to their density. The relation exists strictly between the density of the organic particles suspended in the atmosphere and the mortality; but the density of the matter in the air cannot be determined directly, for obvious reasons; and with the same number of persons on a square mile, the number of particles in the atmosphere will vary in different districts, according as the means of removing the refuse matter, by sewerage and other means, are more or less efficient. Still by taking districts, which, if the circumstances are not quite the same, and the populations are not entirely homogeneous, will yet have atmospheres which bear a certain specific relation to the numbers living on the same area, it will not be difficult to obtain interesting results.

"It is proved beyond doubt that, if the population be the same in other respects, an increase of density implies an increase of mortality; and that the ratio of increase in the mortality is as certain roots of the density. If a further and more extended inquiry, into which I have not time now to enter, should confirm the principle that the ratio of mortality in towns is as the 6th roots of the density of the population, it will be time enough to ask why this should be the particular ratio. But the chemists must first discover means of determining the density of the atmosphere of organic matter, which may be called the *zymotic atmosphere*, in different districts. The density of population is no strict measure of the density of the zymotic atmosphere; nor, admitting that the matter is a poison, does the relative density of the population express the relative doses inhaled in a given time; if it did, it is improbable, and contrary to all analogy, that the mortality should increase in the simple ratio of the dose. The exact effect of increasing doses of poison has not been accurately determined; but it is well known that small doses of all poison are taken with impunity, and that the dose of arsenic, opium, or prussic acid, may be increased up to a given point, at which the dis-



ease produced is severe or fatal. Four drops of prussic acid, diluted, may be taken with safety, when four drops more would be fatal to a certain number of persons. How large, or, rather, how small, the dose of matter may be which will produce a zymotic disease it is impossible to say; but if a minute diluted charge of *vaccinæ* (vaccine lymph) produce cow-pox, say one time in 1000, it would be an interesting problem to determine, by doubling the quantity, in what ratio the proportions infected increased."

It is interesting to find—as we do by the following quotations—that the labours of those who have recently devoted so much attention to vital statistics and the laws of hygiene, have been put to profit and already furnished important results. "We hope," says Mr. Farr, "to be able to determine more exactly, at some future time, the effects of the different external agents on health and the duration of life; in the meantime the results already obtained suggest two or three practical inferences, which I respectfully submit to those authorities who have the means of carrying sanitary measures into effect, not as new, but as resting on a more extended series of observations and calculations than have before been at our disposal."

"The Appendix to the First Report of the Registrar-General had the following statement, which is borne out by the experience of the four subsequent years:—

"The mortality of cities in England and Wales is high, but it may be immeasurably reduced. A good, general system of sewers, the intersection of the dense, crowded districts of the metropolis by a few spacious streets, and a park in the east end of London, would probably diminish the annual deaths by several thousands, prevent many years of sickness, and add several years to the lives of the entire population."

"This passage, with others in the interesting sanitary reports of Drs. Arnott, Kay, and Southwood Smith, with the facts disclosed by registration, were brought by the inhabitants of the Tower Hamlets under the notice of her majesty's government, who, in a very liberal and kindly spirit, introduced a bill into Parliament, and carried it, for founding the Victoria Park, 'in the east end of the metropolis.' Wider streets have already been carried through the densest districts, and others are projected. The results which have been arrived at in this paper justify and confirm in the fullest manner the utility of these measures, and will, I hope, lead to their extension, not only in the metropolis, but in the other cities of the kingdom."

"All 'improvements' disturb property, and injure individual interests; they are, therefore, not only attended by expense, but open to positive objections, over which it can only be shown that the advantages preponderate. The 'improvements' which followed the fire of London were obtained at the expense not only of much loss of property and inconvenience, but of suffering and death; still if the result was the annihilation of plague, which destroyed not the houses but the lives of the great mass of the population every 10 or 20 years, drove the court and parliament from London, spread through the kingdom, paralyzed trade, and was attended by a host of less dreaded maladies, which cut short and embittered life, the improvements were cheaply purchased. It has been stated that the narrow streets and overhanging houses, which are so common on the continent, and of which too many traces remain in England, were erected in close contiguity, among other reasons, for the sake of the shade which they afforded in summer and the shelter in winter; it is now known that this form of building, by obstructing the sunshine and atmospheric currents, is the cause of innumerable diseases; and notwithstanding the cost of any extensive alterations, there can be no doubt that it would be repaid by the amelioration of the health of present and future generations. To take down and rebuild whole districts at once is however impracticable; the best that can be done in the circumstances is to cut open spacious streets, which will carry and produce streams of air through the densest parts, drawing lateral currents from the adjacent narrow streets. Upon visiting some of the unhealthiest districts of the metropolis, I was greatly struck with the number of courts, or streets shut up at the end, particularly in the city of London without the walls; as the wind cannot pass through them, it is evident that the inelastic matter so abundantly generated must be slowly replaced: why should not all these courts be opened at once? Compared with other 'improvements,' the expense would be inconsiderable."

"The inhabitants of the 'rookeries,' which have been recently taken down, are dispersed. It would be interesting to know in what places they are now located. The objection to these measures is that 'you take down the dwellings of the poor, build houses in their places for which the middle classes only can pay, and thus by diminishing the amount of cheap house accommodation increase the rents, and aggravate the evil which you attempt to cure.' It is undoubtedly much easier to displace than to regenerate such a population—the sediment of vast cities which sinks into these obscure receptacles. If the displacement be gradual, however, the inconveniences of removal are diminished: and on a small scale it can have no influence on rents; the people dispersed, if they obtain money obtain houses; or they return, like the Irish, home. The working classes, also, in cities, get lodged in the larger houses of the tradespeople and merchants, who from the facilities afforded by omnibuses and railways, live every year in greater numbers out of town."

As a branch of this important subject, Mr. Farr has thrown out many useful suggestions relative to the means to be employed for the diminution of the quantity of animal and vegetable matter introduced into the atmosphere of towns. These suggestions result from most extensive observation, and are contained in a volume which does not admit of republication in this country. Hence the importance of condensing as much of the most valuable matter as possible, in the pages of this Journal, where it will be read with interest and remain for future reference.

The chief city impurities are the halitus, from the breath and perspiration of living animals, the gases from privies, burial-grounds, slaughter-houses, streets and sewers. As the halitus cannot be diminished in quantity, the only thing that remains to be done is to prevent its undue accumulation in particular places. "While," he observes, "the collection of persons in Robert Owen's parallelograms, and in public institutions, barracks, large schools, prisons, workhouses, must necessarily lead to the concentration of the respiratory excretion, particularly when, as is too frequently the case, the sleeping apartments are crowded, and no mechanical means are employed to facilitate ventilation. A public institution in the periodical epidemics, is like a town without party walls in a fire; nothing but a natural immunity can prevent the propagation of the zymotic action through the imprisoned atmosphere from person to person. According to the common estimate 4 in 100 persons are sick, and as in the metropolis there are 75 persons in 10 houses, one person in every fourth house must be ill, while one in every eighth house will be afflicted with a disease of considerable severity. When the house is small and perhaps dirty, it appears a great act of charity, to remove a poor man suffering from fever for instance to a hospital, where he is provided not only with skillful medical attendance and with physic, but with the proper diet, warmth, and nursing. But have the benevolent founders of hospitals, and the medical officers who generally give their services gratuitously, sufficiently reflected on the probable consequences of bringing 50, 100, 300, or 400 sick bodies under the same roof, and into a few wards, which the sickly breath saturates? Have they ever compared the results of cases treated in hospitals, and in the poorest homes? When hospitals are crowded the increase of mortality soon becomes striking. In the Hôtel Dieu at one time 1 in every 4 persons who entered the pestilential walls died.\* The mortality in the large metropolitan hospitals is twice as great as in the smaller country hospitals. This cannot be ascribed to defect of medical skill in the metropolis. Erysipelas and gangrene are still not infrequent in hospitals. The patient is fortunate who escapes phlebitis, or purulent deposits, after any serious operation in a hospital. It is the adventitious disease, and not the knife of the surgeon that is fatal. Are not the effects of general hospitals of the same nature as those that have more than once led to the evacuation of lying-in hospitals? I have rarely seen any statement of the mortality of cases of fever, small-pox, or any other disease, in which it did not appear that a person was twice as likely to die in a hospital as a person suffering from the same disease out of doors. It is generally said, 'Yes, we admit that our mortality is high,

\* Il périssait (18th century) le quart de ce qui y entraît et la moitié du reste n'en sortait qu'après avoir échangé une maladie en elle-même de peu de durée contre une langueur sans remède.—*Eloges Historiques par Cuvier—Tenon.*

but the worst cases are sent in the last stage of disease to the hospital? Is this certain? Will it account for all the difference? I doubt it very much. And I express the doubt in the hope that the question may be strictly, honestly, and conscientiously investigated by some qualified person who has time to devote to the subject. Until this be done no attempt should be made to extend the system of assembling the sick in the same buildings.

"The expense of a patient in a hospital is from 7s. to 14s. a-week. What would be the effect of allowing a married man in a fever the same nutriment at home, supplying him with an occasional nurse, and seeing that his house was well cleaned and kept comfortable? He would be surrounded by those who from natural affection loved him, instead of the dying and dead in the wards of a hospital. Would not this be an excellent season, too, for religion, charity, and science, to instil just principles and habits into the families of the poor—to ameliorate their homes—so that the sick man may not, as when he returns from a hospital alive and convalescent, be exposed to the same agencies as produced the previous attack?

"The space allotted to the sleeping-rooms of many public institutions in towns is too small. It should in no case be less than 8 feet cube (=512 cubic feet) to each person, with proper apertures for the removal of the breath. If the air were removed twice as fast, a room of 500 cubic feet would be equal to a room of 1000 cubic feet; but it is a difficult matter to remove air from a room with a double velocity—more difficult and expensive than to make the rooms, at least on land, of sufficient extent in the first instance. The influence of a too limited space, if carefully investigated, would no doubt show a certain inverse relation between the mortality and the space, a death marking every degree of concentration of the expired atmosphere. The families of many artisans who get good wages lodge in a single small room, the rent of which is equal to that of a cottage in the country. This is a miscalculation on their part; on coming from the country they get in town higher wages, and could afford to pay for more expensive lodgings, but finding they can live in one room, do so, expending the surplus wages on dress, beer, and better food. To forego these would be to curb a natural appetite; they are only reminded of the want of room and pure air by a slight present uneasiness, and discomfort. As they do not trace to their causes the deaths of their children, and disabling, dangerous attacks of sickness, they are led to look upon these events as inevitable. With the limited income at his command, a working man in a town is compelled to practice self-denial; now calculation shows that clean spacious lodging is one of the most necessary things to the maintenance of health, and that it is safer to refrain from other things, such as beer, which, though nutritious, is not indispensable, while spirits are more frequently injurious than beneficial.

"Cuvier's definition of life, or of a living thing, in its utmost generalitv, is so strictly applicable to a city, that 'London' may be substituted for '*la vie*' in the following sentence:—

"*'La vie est donc un tourbillon plus ou moins rapide, plus ou moins compliqué, dont la direction est constante, et qui entraîne toujours des molécules de mêmes sortes, mais où les molécules individuelles entrent et d'où elles sortent continuellement, de manière que la forme du corps vivant lui est plus essentielle que sa matière.\*'*

"It would be easy to draw the parallel. But I wish merely to remark, that if it is of vital importance to procure the flow of a constant stream of sustenance into a city, it is equally important that the used matter, animal or vegetable, when it has entered and passed through the 'tourbillon,' should be restored back to its source, or be at least removed. In effecting this, art and labour are required, as well to return as to bring in the organized matter, yet it could not be expected while people remained ignorant of the fact that the accumulation of effete matter is as fatal to a population as famine, that they should be ready to incur any great expense for its removal.

"The present investigation fortifies the frequent recommendations which have been made in these reports, and in all works on public health, with regard to sewerage. I shall not refer to the subject further at the present time, as it has occu-

pied the special attention of the 'Health of Towns Commission,' comprising among its members distinguished persons largely interested in property, as well as gentlemen of great sagacity and scientific knowledge, from whom may be expected such practical suggestions on the subject as shall serve for the basis of an act of Parliament, regulating, by some simple provisions, the entire architectural structure of towns.

"I have stated, in previous papers, that we should not rest satisfied with throwing the refuse of towns into the rivers, as this refuse matter, which in certain circumstances is a poison to man, is the nutriment of vegetation, and constitutes, with water, the difference between the barren desert and populous kingdoms. The more organic matter there is, the more subsistence—the cheaper food will be. If Mr. Martin's grand and magnificent conceptions cannot be carried out, the ingenious suggestion of Dr. Arnott deserves to be seriously considered. 'Engineers who pump from the Thames many miles above London, to supply pure water to the inhabitants, could as easily, by pumping away to any desired distance the fluid from the drains, supply the most valuable manure yet known—fluid town manure—to the horticulture and agriculture of the district; and the purity and beauty of the Thames, where it passes through London, would be preserved. Fluid manure, by sinking at once into the earth, is much less offensive to the neighbourhood, and affects less the purity of the atmosphere, than an equal quantity of solid manure, spread, as it usually is, on the surface of the earth.\*'

"Whether the remark in the last sentence is correct, we are perhaps not quite prepared to say; but no matter of the kind appears to be sensibly injurious to animals when it is in contact with vigorous vegetation, and is not present in excess. If the irrigation, in an instance referred to by Dr. Alison, convert the meadows around Edinburgh into 'putrid marshes,' it would be in the teeth of all analogy to infer that the practice is innoxious; but if it render the soil more fertile, and is not in excess as manure, it must be inoffensive to the health of Edinburgh. Upon the same principle drainage, and all the improvements of agriculture, which tend to increase and invigorate vegetation, to the same extent absorb, impress vitality on decaying matter, and promote the health of the population.

"Much of the putrefying atmosphere of English towns would be got rid of, by removing the cattle markets, slaughter-houses, and manufactories of the animal remains to convenient, distant localities. At present the greatest amount of putrid matter is accumulated in districts like Whitechapel, and the city of London without the walls, where the population is most dense, or the sewerage is most imperfect."

One of the most effective means of introducing sanitary measures calculated to lessen the evils existing in crowded communities, Dr. Farr thinks would be the diffusion of such knowledge as would satisfy the public of the intimate connection between the causes of insalubrity and the excessive number of deaths in towns. "The middle classes," he says, "are now very easily put in possession of the facts relating to health by the popular literature of the day, and will probably be, ere long, sufficiently convinced to induce them to incur the expense necessary for the improvement of the districts in which they live. That conviction has not yet reached this point in many towns is to be greatly regretted. After all the public measures have been introduced, to which the poor have no means of contributing, much will remain for them to achieve by their own exertions. It is important, therefore, that they should be made aware of the few simple facts and principles which demonstrate the effects on their families of cleanliness, ventilation, and the observation of the rules of health. Their minds would thus be carried along with the improvements, and would second instead of thwarting them. Few men like to be compelled to do what they are told—but have not the means of knowing—is for their own interest; and this feeling is quite as strong in the worst as in the best parts of London. Much will be effected by example. The higher classes in this country were, not many years ago, intemperate; they became aware that it was injurious to health; and, from this and other motives, are now as temperate, on the whole, as can for the 'health's sake' be desired. The poor, in the worst districts, will no doubt ultimately follow the example, and expend

\* Dr. Arnott's Sanitary Reports; *Local Sanitary Reports*, Scotland, p. 12.

the money on lodging and food which they now waste on spirits. I have before adverted to the influence of medical advice on the habits of the poor; information may also reach them through newspapers which circulate in their districts. Tracts on health may perhaps be distributed with advantage, or persons may be employed to lecture to and converse with them on the subject. In the worst districts the poor reason; for I cannot agree with an eloquent passage in Dr. Southwood Smith's valuable evidence, to the effect that, in towns, 'physical wretchedness annihilates the mental faculties;' although it is admitted that it dwarfs and obscures many of 'the faculties distinctive of the human being.'<sup>26</sup>

"Until latterly," he continues, "the government of this country has done little directly to promote the public health; for one obvious reason, that the causes of insalubrity were not well known, and it was not clear that anything useful could be done; such distinguished writers as Dr. Price, who were well aware of the excessive mortality of towns, ascribing it, among other causes, to 'luxury.' Now that the legislature and the government, having become acquainted with the evil, have evinced the best disposition to investigate its nature and to introduce measures for its removal, care must be taken to discriminate between what can be done by legislation for the people, and what can only be accomplished by themselves individually, and swayed by the slow progress of opinion. Over the supply of water—the sewerage—the burial places—the width of streets—the removal of public nuisances—the poor can have no command; it is only by choosing and paying better rents for well-constructed houses that they can exercise any influence on the landlords; and it is precisely upon those points that the government can interfere with most advantage. The legislature would enact the removal of known sources of disease, and, if necessary, trench upon the liberty of the subject and the privileges of property, upon the same principle that it arrests and removes murderers, who, if left unmolested, would probably only destroy lives by hundreds, while the physical causes, which have been adverted to in this paper, destroy thousands—hundreds of thousands of lives. The movement for the sanitary improvements of towns must originate, it is true, and be carried out in a great measure by the educated and more intelligent classes,—by the statesman,—because the causes in question are not palpable, cannot be seen, and are only discovered by extended observation, calculation, and abstract reasoning. Upon such subjects there can be no excitement. Still much may be done with the people, as well as for them. Health is as dear to the poor as to the rich. The most abject part of the population—creatures who belong to no class, but are the reprobates, unfortunate, and fallen of all classes—can understand its value; and, as we know, are capable of making sacrifices for the good of others; what may not then be expected from the great mass of the labouring population, from the intelligent artisans of towns, who are so apt in acquiring their difficult arts, and are certainly not surpassed by other classes in the facility with which they grasp and carry out a scientific principle clearly announced. To leave many things to the people themselves will be to proceed slowly, because knowledge and new principles on such subjects can only be communicated slowly, but it will be to proceed surely—and the improvement will not die away or be superficial, for it will be the act of the mind, penetrate the inmost recesses of home, and be imparted to future generations."

G. E. .

\* Dr. Smith quotes a remark by the medical officer of the West Derby Union:—"Amidst the greatest destitution and want of domestic comfort, I have never heard, during the course of 12 years practice, a complaint of inconvenient accommodation." Upon which Dr. Smith makes this eloquent comment:—"Now this want of complaint, under such circumstances, appears to me to constitute a very melancholy part of this condition; it shows that physical wretchedness has done its worst on the human sufferer, for it has destroyed his mind. The wretchedness being greater than humanity can bear, annihilates the mental faculties,—the faculties distinctive of the human being. There is a kind of satisfaction in the thought, for it sets a limit to the capacity of suffering, which would otherwise be without bound."